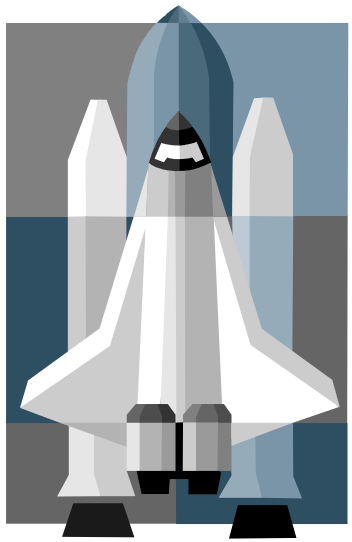
Integrating Human Factors into Space Vehicle Processing for Risk Management



NASA Project Management Challenge 2008

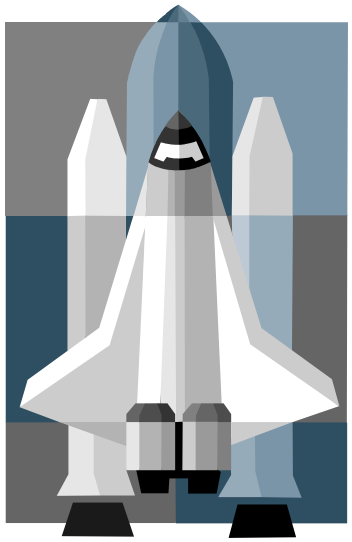
February 26-27

Kim Richards

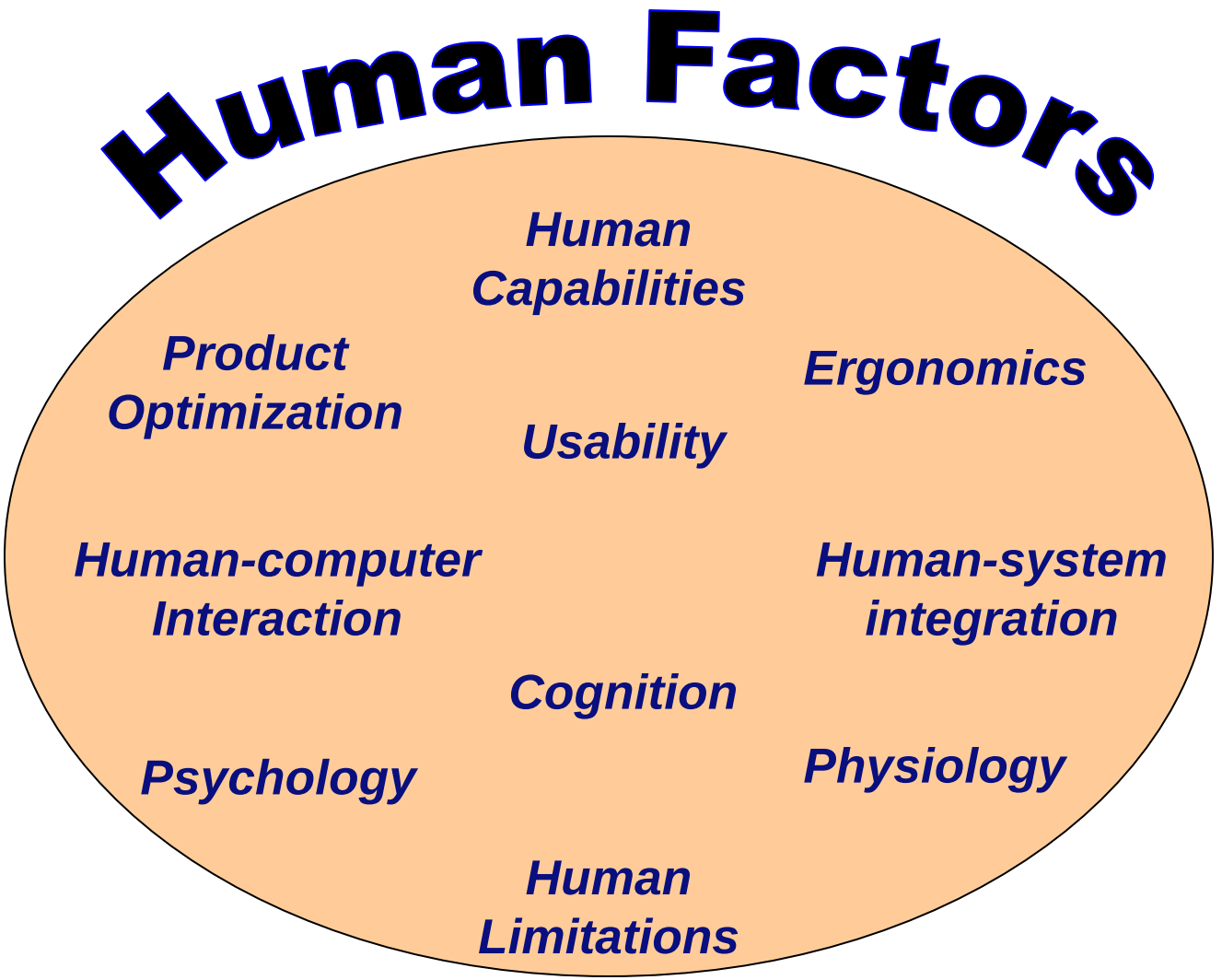
Kimberly.j.richards@usa-spaceops.com

Sarah Woodbury

Sarah.k.woodbury@usa-spaceops.com



What is Human Factors Engineering?



The Reality of Space Vehicle Processing

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Design for Usability…

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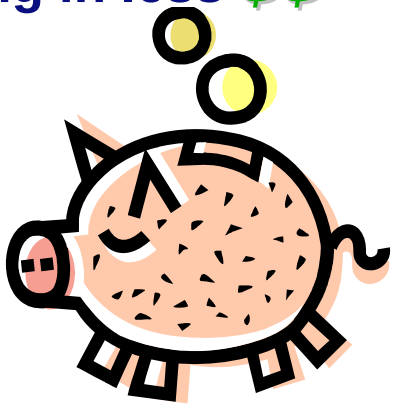
Our Goal? Proactive, not Reactive!

- **Consideration of human capabilities and limitations *before* designing products is the *#1* way to manage risk to our most valuable resources: PEOPLE!**

- **Designing products that are intuitive and user-friendly will minimize frustration and human error, resulting in less *$$* spent for redesigns and repairs!**



A Step in the Right Direction

- **USA's implementation of the Human Engineering Modeling and Performance (HEMAP) Lab**
  - **Utilizes COTS motion capture system to capture motions of humans and objects, then displays data in a real-time 3D environment**
  - **Utilizes COTS HF modeling software that provides ergonomic analyses of high-risk operations involving heavy lifting, awkward postures, repetitive motions, and difficult reach positions, and process flow operations.**

Cameras capture sensors strategically placed on human body

USA
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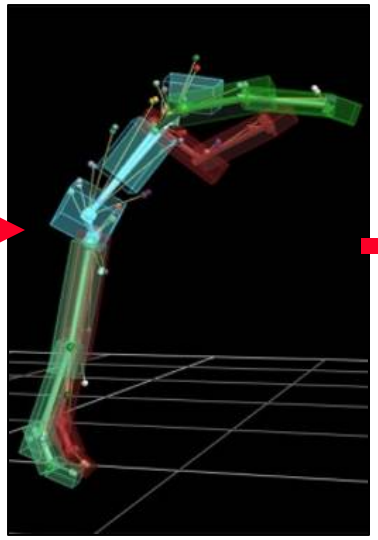
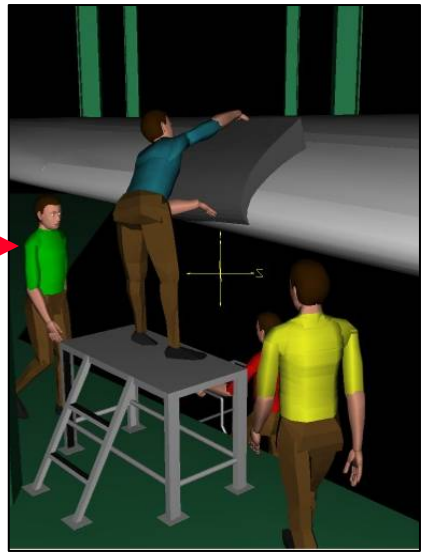
How it's Done: Flow of Activities

Real-time Task

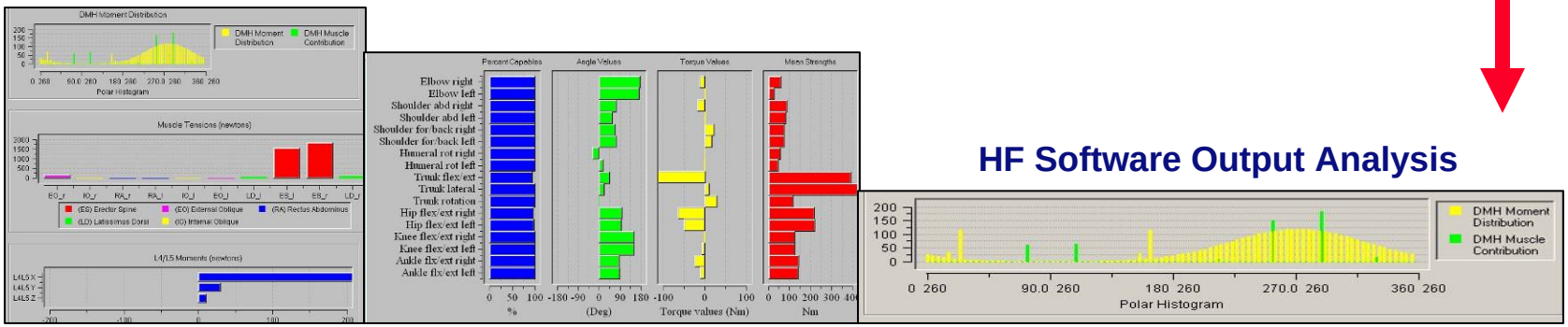
Simulated Task



Motion Capture Simulation



HF Software Model



HF Software Output Analysis

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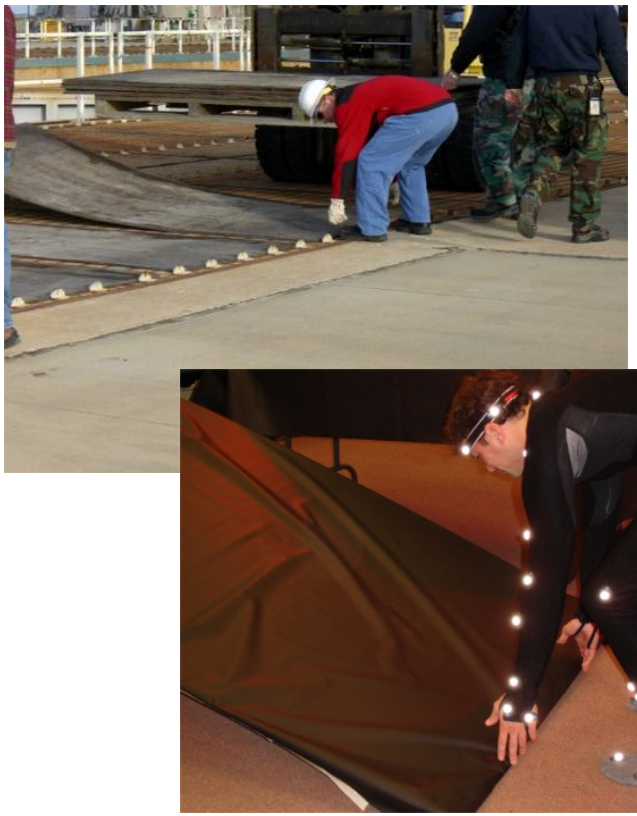
Task Analysis Tools

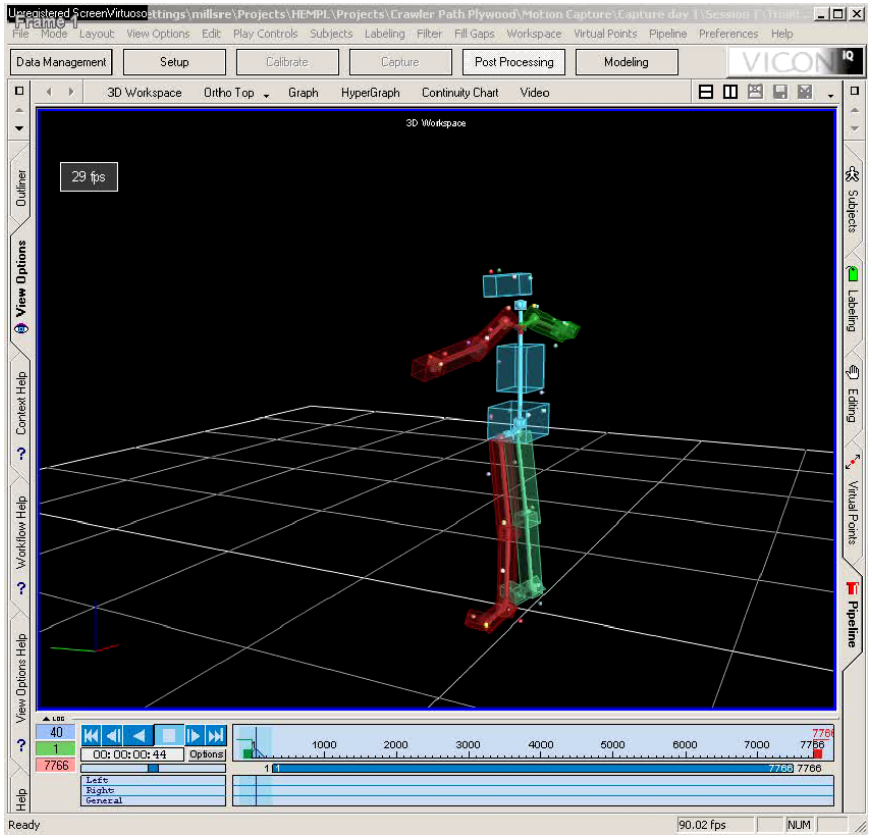
- **The NIOSH Lifting tool:**
  - **Evaluates symmetrical and asymmetrical lifting tasks, including lifts with less than optimal couplings between the object and the worker's hands**
- **Metabolic Energy Expenditure:**
  - **Predicts metabolic energy expenditure requirements of a job based on worker characteristics and a description of the simple tasks that comprise the job**
- **Low Back Compression Analysis:**
  - **Evaluates spinal forces acting on a virtual human's lower back, under any posture and loading condition**
- **Fatigue and Recovery Analysis:**
  - **Assesses whether enough recovery time is available for a given job to avoid worker fatigue**

Task Analysis Tools

- **Manual Material Handling Limits:**
  - **Evaluate and design manual handling tasks involving lifting, lowering, pushing, pulling and carrying for reduced risk of low back pain**
- **Rapid Upper Limb Assessment (RULA):**
  - **Evaluates the exposure of workers to the risk of upper limb disorders**
- **Static Strength Prediction:**
  - **Evaluates the percentage of a worker population that has the strength to perform a task based on posture, exertion requirements and anthropometry**

Project: Crawler Plywood





The problem: Repetitive lifting and bending to place 400 sheets of plywood on launch pad for crawler transporter, and hammering wedges into place to secure plywood on crawler path

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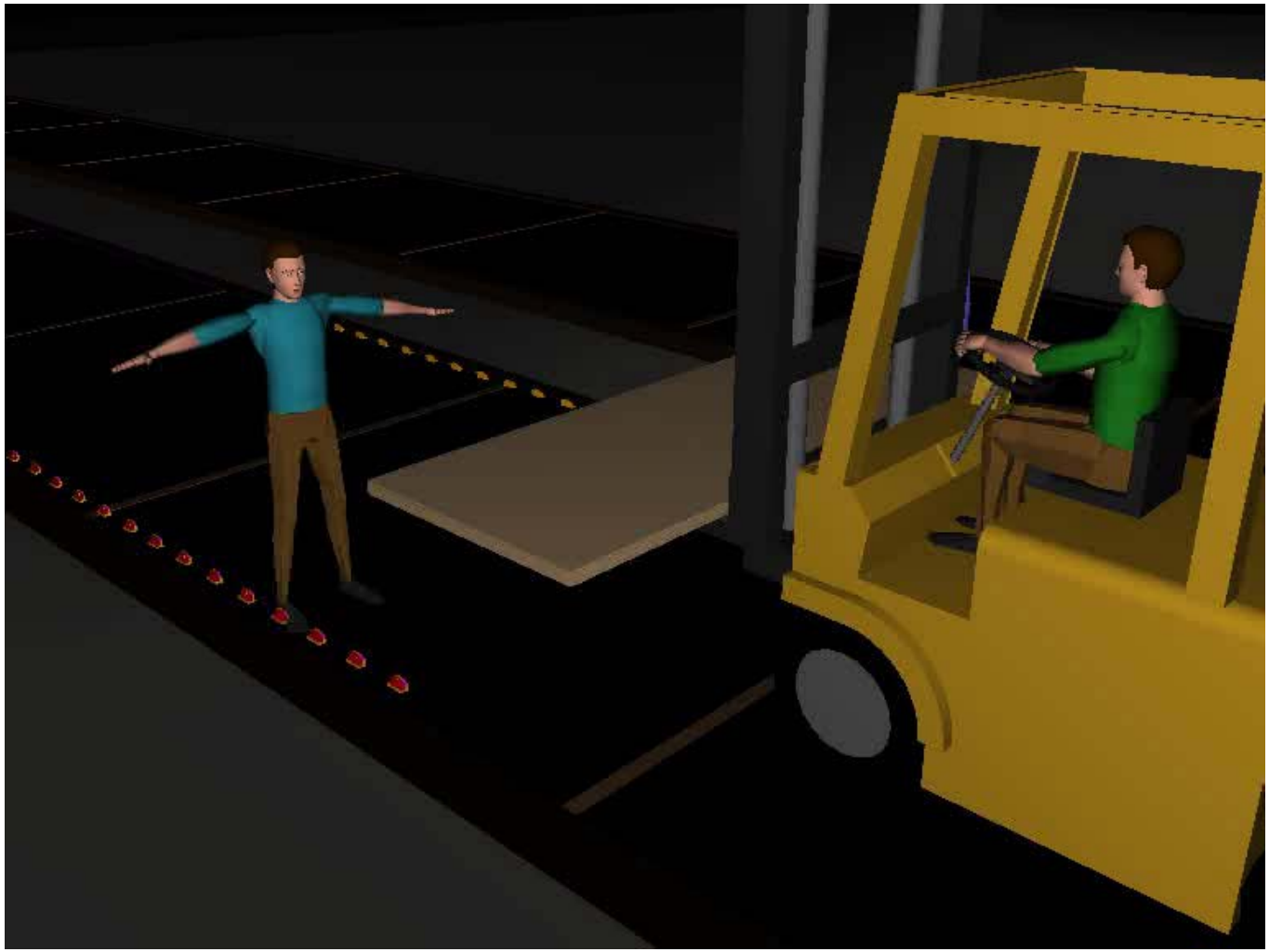
Project: Crawler Plywood



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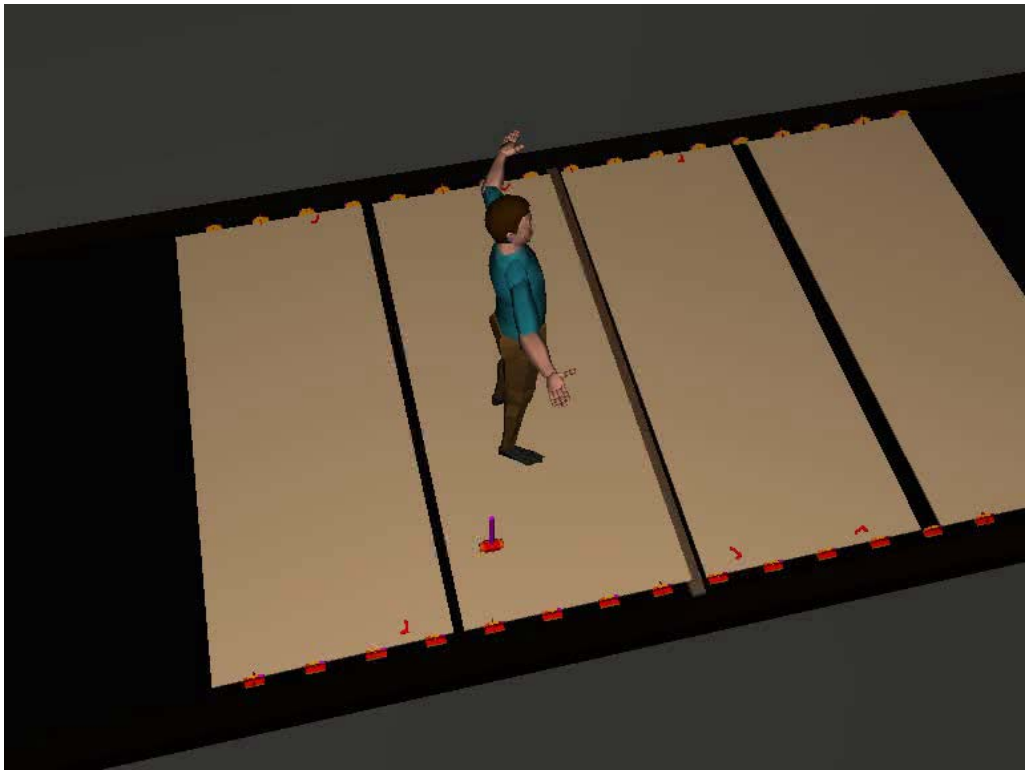
Project: Crawler Plywood



Project: Crawler Plywood

The fix: Cable system and forklift attachments to drop plywood into place

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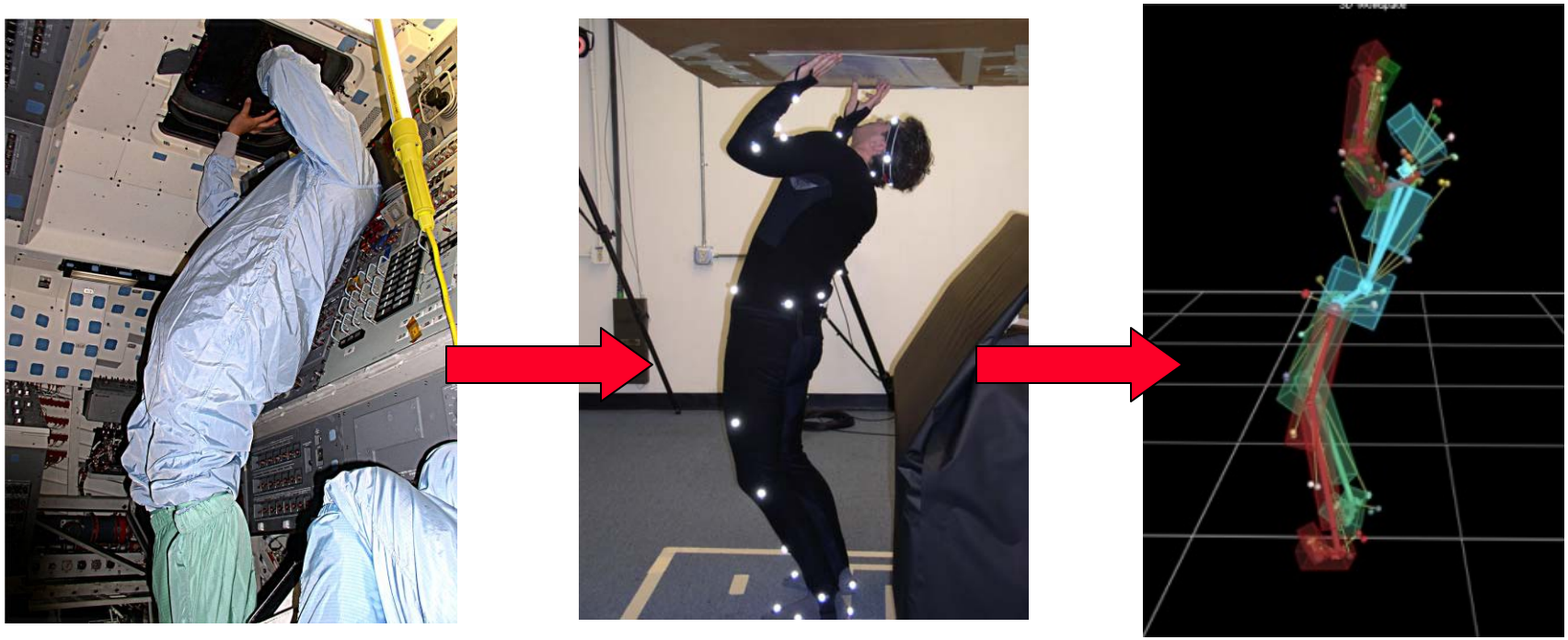
Project: Window Polycarbonate Cover Installation

The problem: Difficulty installing polycarbonate shields over orbiter windows. This is a static body position that requires the person to reach overhead for up to 20-30 minutes



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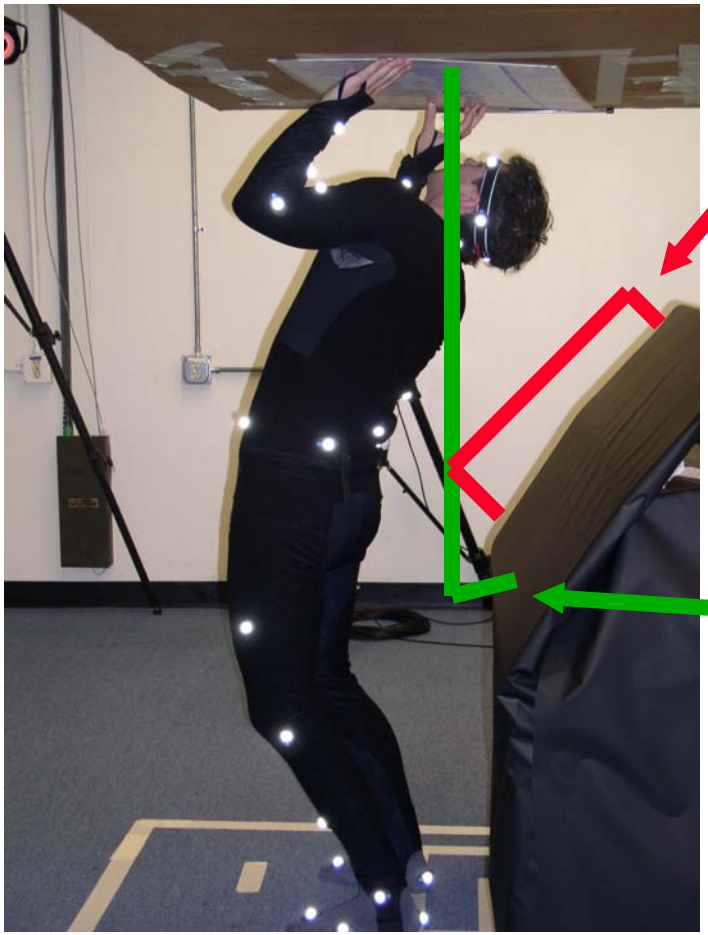
Project: Window Polycarbonate Cover Installation

The fix: Back and shield support



Back pad will extend 7 inches out from the panel and will run the length of the panel

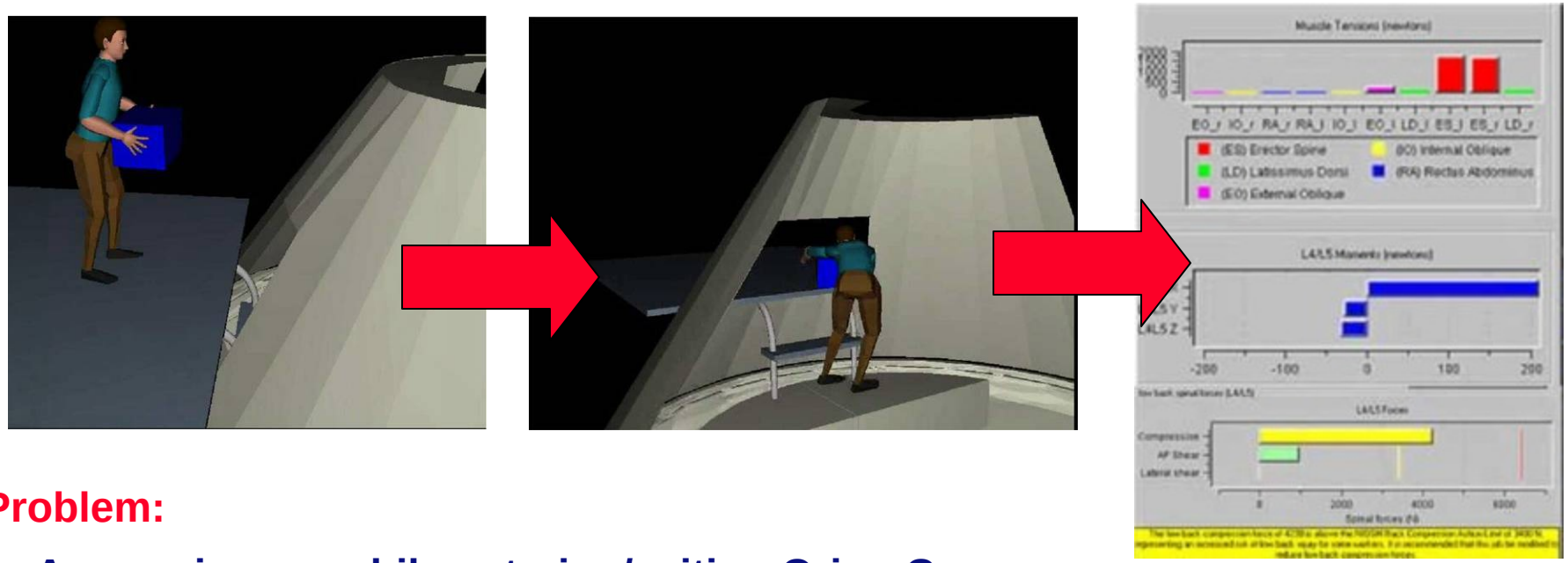
Shield support will attach to bottom of panel and extend upward to hold the shield in place during build-up, eliminating the need for a human to manually hold the shield in place

Project: Ingress/Egress through Orion Crew Hatch

- **A *proactive* approach to evaluate how employees will access and transport items through the crew hatch**

So we are identifying potential risks before they become a problem!!!

Project: Ingress/Egress through Orion Crew Hatch



Problem:

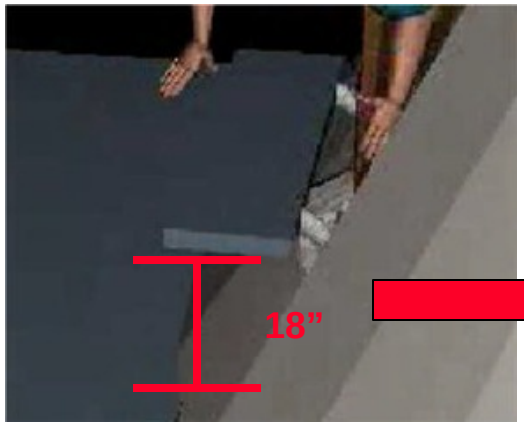
Access issues while entering/exiting Orion Crew Module

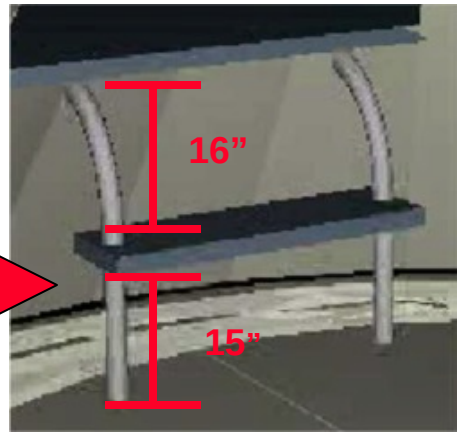
Plan:

To mitigate the excessive bending and twisting during ingress/egress

Simulated a worst case and best case scenario

Project: Ingress/Egress through Orion Crew Hatch





Best Case: 18” step/seat

Worst Case:

- **Identified increased lower back compression forces while entering through the crew hatch when platform is flush with hatch entry**

Best Case:

- **Design a step/seat that is 18” above the platform for the technician to use for ingress/egress.**
  - **Reduces the low back compression forces, I.e., bending and twisting**

Beyond Shuttle: Oh, the Possibilities…

- **What can YOU do to reduce risk to employees AND flight hardware in your environment?**
  - **Take the time to identify risks FIRST…down to the smallest tasks**
  - **Think PROACTIVE when designing new products OR processes—it's easier to change the design on paper than after it's been implemented!**
  - **Talk to the people who actually perform the work. Their input is invaluable.**
  - **RUN TESTS to identify optimal designs and configurations**
  - **WALK THROUGH the ENTIRE process, from start to finish, and remember to have a reaction plan for off-nominal situations**

- **During the design phase, interview the users and develop requirements to ensure a user friendly product….**

But remember it is the DESIGNER'S responsibility to identify the risk, minimize it, and provide an intuitive, error-free product!

Questions

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